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Problem 26.7 (RHK)

Engine A, compared to engine B, produces per cycle, five times the work but receives three times the heat input and exhausts twice the heat out. We have to determine the efficiency of each engine.

Solution:

Let the heat input, work output, and heat exhaust of the engine *A* be Q_{1A}, W_A, and Q_{2A}, respectively. Let the same thermodynamic quantities for the engine B be denoted by Q_{1B}, W_B, and Q_{2B}.

From the data of the problem we relate these quantities. We have

$W_A = 5W_B$,

$Q_{1A} = 3Q_{1B}$,

and

$Q_{2A} = 2Q_{2B}$.

From energy conservation, we have

$Q_{1A} = W_A + Q_{2A}$,

and

$$Q_{1B} = W_B + Q_{2B}.$$

Solving these algebraic equations, we easily find

$$Q_{1B} = 3W_B.$$

Therefore, the efficiency of the engine *B* is

$$e_B = \frac{W_B}{Q_{1B}} = \frac{1}{3} = 0.33.$$

That is the efficiency of the engine *B* is 33.3%.

And,

$$e_A = \frac{W_A}{Q_{1A}} = \frac{5W_B}{3Q_{1B}} = \frac{5}{9} = 0.56.$$

That is the efficiency of the engine *A* is 56%.